

Interpretation of Human Stages from EEG Signals Using LabVIEW

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Abstract: This document describes the analysis of Electroencephalogram (EEG) or brain signals using computational tool (LabVIEW) to interpret human stages such as drowsiness, sleepy state etc. Different thoughts and human stages generate different EEG signals. LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a graphical programming language that uses icons instead of lines of text to create applications. The EEG signals are analysed in LabVIEW to reveal the features which describes the human stage. Various filters are used to extract the feature and comparison between the outputs of all filters is also done. This feature will indicate the stage. This result could be displayed using an external hardware indicator. This determined stages or emotions could find applications in various fields such as robotics, mobility control etc. Throughout the project the brain signals will undergo signal conditioning and processing to extract the feature which will determine the human stage.

Keywords: EEG, Lab VIEW, human stages, indicator.

I. INTRODUCTION

EEG or brain signals are the electrical activity of brain. Commonly the EEG waves range from 0.5-500 Hz. There are six frequency bands of brain signals, which are Alpha band, Beta band, Theta band, Delta band, Gamma band and Mu band. Delta waves frequency is from .5 to 3 Hz. It is the dominant rhythm during deep or dreamless sleep. Theta waves frequency ranges from 4 to 7 Hz. It is slowest wave and is the dominant rhythm in adults. It appears with closing of eyes and disappears normally with opening of eyes. Alpha waves have a frequency range from 7 to 12 Hz. It is most commonly seen in adults.

Alpha activity occurs rhythmically on the occipital regions. It emerges with closing of the eyes and with relaxation. It is regarded as a normal waveform. Beta wave has frequency ranges from 13 to 30 Hz. It is the dominant rhythm during alert or anxious states. It is usually observed from the frontal and central portions on the brain. It is generally a normal rhythm and is observed in all age groups. Gamma wave is fastest wave of brain and having a frequency ranges from 30 to 45 Hz and is normally called as fast beta wave but its presence is rarely felt. These waves are occurred in front central part of the brain. The EEG signals can be captured using various techniques.

In conventional scalp EEG, the recording is obtained by placing electrodes on the scalp with a conductive gel or paste, usually after preparing the scalp area by light abrasion to reduce impedance due to dead skin cells. Many systems typically use electrodes, each of which is attached to an individual wire. Else the EEG signals can be captured with open source hardware such as Open BCI and the signal can be processed by freely available EEG software such as EEGLAB or the Neuro physiological Biomarker Toolbox. Use of EMOTIV EPOC EEG

amplifier and electrodes is another method used to capture the EEG signals from the subjects.

Different methods and tools are being developed to analyse EEG signals. The most common is the spectral analysis- mainly the power spectrum of the EEG signal is analysed to extract EEG features. Fourier transform analysis is another method to analyse the EEG signals. Lab VIEW can be considered as the most effective tool to analyse EEG. The signal acquired should be free from all kinds of artifacts.

II. METHODOLOGY

A. EEG EXTRACTION

A routine clinical EEG recording typically lasts 20–30 minutes (plus preparation time) and usually involves recording from scalp electrodes. The EMOTIV EPOC EEG amplifier and electrodes are used to capture the EEG signals from the subject. There are a total of 14 measurement points. The raw data of EEG signals are sent to computer via Bluetooth and then saved as .edf file. Next, the data are transferred to Lab VIEW for analysing and identification of the EEG features.

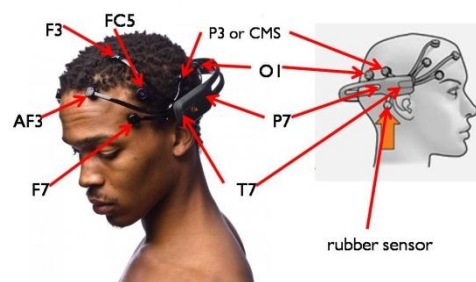


Fig. 1 EEG electrodes and measuring points using EMOTIV-EPOC system

EEG signal could also be easily simulated in Lab VIEW using biomedical toolkit. The signal is analysed to determine the human stage. EEG signals ranges from .5 to 500Hz. It is simulated using EEG simulator module in LabVIEW. Simulated EEG signal contain delta, theta, alpha, beta, gamma frequency rhythms. Each rhythms represent different human stages.

TABLE: I FREQUENCY BANDS AND CORRESPONDING STAGES

Brainwave Type	Frequency Range	Mental states and conditions
Delta	.5Hz to 3Hz	Deep, dreamless sleep
Theta	4Hz to 7Hz	Fantasy, imaginary dream
Alpha	8Hz to 12Hz	Relaxed but not drowsy
Low Beta	13Hz to 15Hz	Formerly SMR
Midrange Beta	16Hz to 20Hz	Thinking, aware of self & surroundings
High Beta	21Hz to 30Hz	Alertness, agitation
Gamma	30Hz to 100Hz	Motor Functions, higher mental activity

B. FILTERING OF SIGNALS

Various filters available in LabVIEW which can be used to filter EEG signals are IIR and FIR filters. FIR filters are designed to provide a linear-phase response and IIR filters provide a nonlinear-phase response. Thus, use FIR filters for applications that require linear-phase responses and IIR filters for applications that do not require phase information, such as signal monitoring applications.

One difference between FIR and IIR filters is the impulse response, which is finite or infinite, respectively. When you design a filter, you must consider other differences between FIR and IIR filters that might affect the design. For example, FIR filter implementations typically require more multiplications and summations than IIR filters with similar filtering performance. However, because certain computer architectures, for example digital signal processors (DSPs), are frequently better suited to perform FIR filtering, the computation speed of an IIR filter is not necessarily faster than an FIR filter.

IIR filters can achieve the same level of attenuation as FIR filters but with far fewer coefficients. Therefore, an IIR filter can provide a significantly faster and more efficient filtering operation than an FIR filter.

In Fig 2, the obtained .edf file is read using Read Bio signal module. The extracted EEG signal is filtered to obtain different frequency rhythms using IIR butter worth

band pass filter. A band pass filter with pass band frequency .5Hz and stop band frequency 3Hz is used to obtain Delta frequency bands. Similarly, Theta waves are obtained using a band pass filter with pass band frequency 4Hz and stop band frequency of 7Hz. Alpha waves are obtained using band pass filter with pass band frequency 8Hz and stop band frequency 12Hz. Similarly, a band pass filter with pass band frequency 13Hz and stop band frequency 30Hz is used to obtain Beta frequency band. Also the corresponding waveforms are displayed. The amplitude and frequency of each frequency band are extracted using the single tone measurement module. A for loop is used to execute the program N number of times.

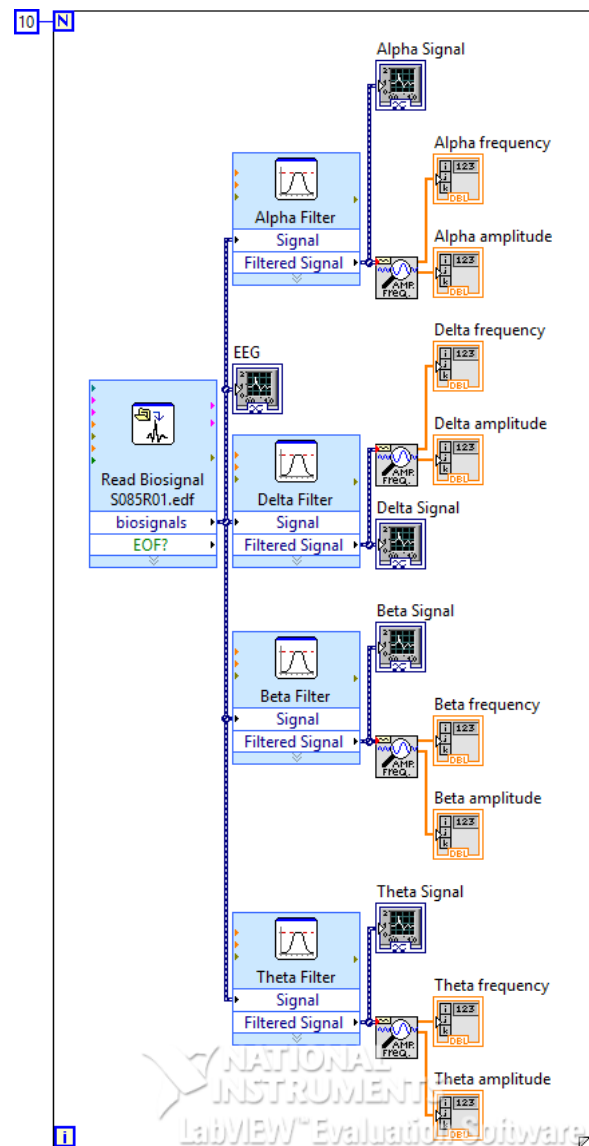


Fig. 2 Block diagram for signal filtering

C. SIGNAL MEASUREMENT

The average feature value of each band is taken using Mean vi. The obtained mean is built into an array and maximum among these values is calculated. If the obtained maximum value corresponds to delta waves it indicates sleepy stage. Similarly theta wave corresponds to dreamy stage, alpha waves shows relaxed stage and beta

waves indicates thinking stage. The LED corresponding to indicated stage blinks as an indication.

A DAQ Assistant module is used to interface the Lab VIEW program with the external hardware. DAQ Assistant, a graphical way to configure virtual channels and measurement tasks for a device and to generate NI-DAQ mx code based on virtual channels and tasks. DAQ provides support and performance for the LabVIEW Real-Time Module.

this study with previous statistics this gives accuracy greater than 80%.

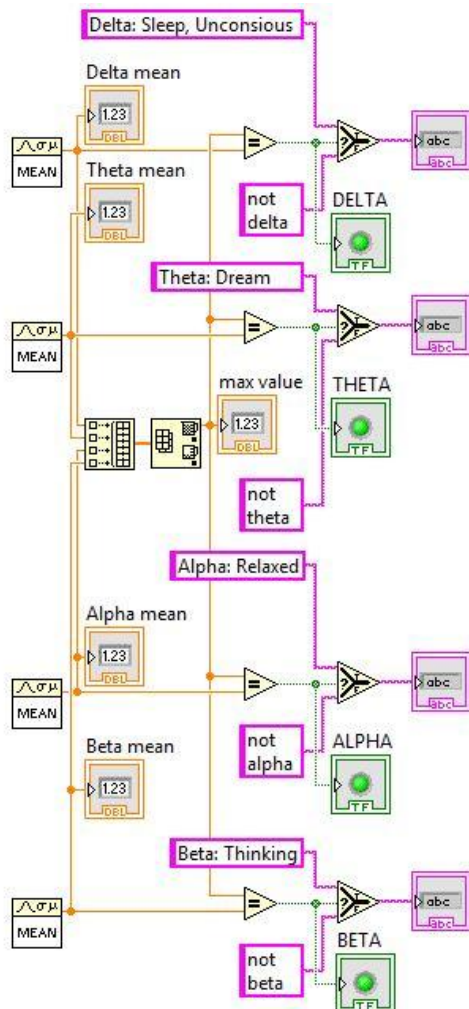


Fig. 3 Block diagram showing mean values and indication of corresponding conditions

III. FUTURE SCOPE

In real time systems, a voice indicator could be used instead of LED array. When implemented in automobiles a vibrator could be connected to the steering wheel to make the driver vigilant.

IV. RESULT AND CONCLUSION

The extracted EEG signal is filtered using IIR butter worth band pass filters and corresponding feature is compared to identify the human conditions using Lab VIEW. The Fig 4 shows the front panel which contains the EEG signal and the filtered frequency bands. The Fig 5 shows the front panel for all means and indicates sleep stage since when compared to all other means delta is dominant. Comparing

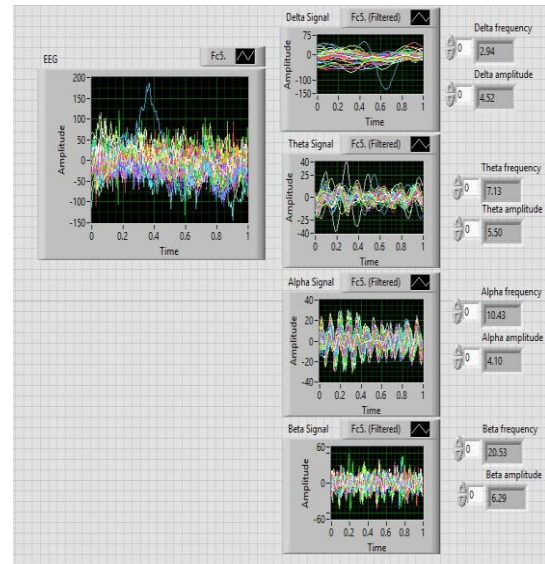


Fig. 4 Front panel for signal filtering

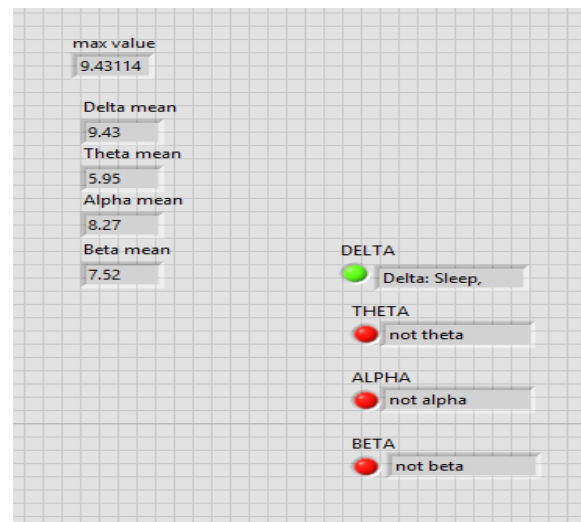


Fig. 5 Front panel showing mean values and indication of sleep stage

ACKNOWLEDGMENT

This work was supported by Mr. K M Abubeker, Assistant Professor, Department of Electronics and Communication Engineering. Also, this article only reflects the authors' views.

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